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1-year risks of cancers associated with COVID-19 vaccination: a large population-based cohort study in South Korea

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Abstract

The oncogenic potential of SARS-CoV-2 has been hypothetically proposed, but real-world data on COVID-19 infection and vaccination are insufficient. Therefore, this large-scale population-based retrospective study in Seoul, South Korea, aimed to estimate the cumulative incidences and subsequent risks of overall cancers 1 year after COVID-19 vaccination. Data from 8,407,849 individuals between 2021 and 2023 were obtained from the Korean National Health Insurance database. The participants were categorized into two groups based on their COVID-19 vaccination status. The risks for overall cancer were assessed using multivariable Cox proportional hazards models, and data were expressed as hazard ratios (HRs) and 95% confidence intervals (CIs).

The HRs of thyroid (HR, 1.351; 95% CI, 1.206–1.514), gastric (HR, 1.335; 95% CI, 1.130–1.576), colorectal (HR, 1.283; 95% CI, 1.122–1.468), lung (HR, 1.533; 95% CI, 1.254–1.874), breast (HR, 1.197; 95% CI, 1.069–1.340), and prostate (HR, 1.687; 95% CI, 1.348–2.111) cancers significantly increased at 1 year post-vaccination. In terms of vaccine type, cDNA vaccines were associated with the increased risks of thyroid, gastric, colorectal, lung, and prostate cancers; mRNA vaccines were linked to the increased risks of thyroid, colorectal, lung, and breast cancers; and heterologous vaccination was related to the increased risks of thyroid and breast cancers. Given the observed associations between COVID-19 vaccination and cancer incidence by age, sex, and vaccine type, further research is needed to determine whether specific vaccination strategies may be optimal for populations in need of COVID-19 vaccination.

Keywords: Cancer, COVID-19, Vaccine, mRNA-based vaccine, cDNA-based vaccine.

Introduction (To the Editor)

Since the Coronavirus disease 2019 (COVID-19) out-break in December 2019, it has become a global concern because of the lack of preventive and treatment options. It is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which is linked to high morbidity and mortality among the elderly. With the rapid development of COVID-19 vaccines, the fatal complications caused by COVID-19 have been alleviated; however, several other issues, including adverse events related to vaccines have emerged.

Similar to other viruses, such as human papillomavirus and Epstein–Barr virus, **SARS-CoV-2 shows an oncogenic potential, which has been hypothetically proposed based on its mechanisms of action, including the renin–angiotensin–aldosterone system, viral mutagenicity, and inflammatory cascade.** Given the shared structures, such as the spike protein in COVID-19 vaccines, we further hypothesized that COVID-19 vaccines might potentially be associated with cancer risks; however, real-world data are insufficient.

Methods and Study Population

In this population-based retrospective study, we estimated the cumulative incidences and risks of cancers 1 year after COVID-19 vaccination. **In the South Korean cohort of 8,407,849 individuals between 2021 and 2023, we finally included 595,007 and 2,380,028 individuals after the 1:4 propensity score matching (PSM).** For the vaccinated population, 355,896 and 711,792 individuals were included in the non-booster and booster groups, after the 1:2 PSM. The measured outcomes were cumulative incidences and corresponding risks of cancers at one year after COVID-19 vaccination, which was also stratified by the types of vaccine, sex and age.

Results

Our data showed associations between COVID-19 vaccination and an increased the risk of six cancer types, namely, thyroid (hazard ratio [HR], 1.35; 95% confidence interval [CI], 1.21–1.51), gastric (HR, 1.34; 95% CI, 1.13–1.58), colorectal (HR, 1.28; 95% CI, 1.12–1.47), lung (HR, 1.533; 95% CI, 1.25–1.87), breast (HR, 1.20; 95% CI, 1.07–1.34), and prostate (HR, 1.69; 95% CI, 1.35–2.11) cancers.

In terms of vaccine type:

- **cDNA vaccines** were associated with the increased risks of thyroid, gastric, colorectal, lung, and prostate cancers.
- **mRNA vaccines** were linked to the increased risks of thyroid, colorectal, lung, and breast cancers.
- **Heterologous vaccination** was related to the increased risks of thyroid and breast cancers.

Stratification analysis revealed:

- Vaccinated males were more vulnerable to gastric and lung cancers, whereas vaccinated females were more susceptible to thyroid and colorectal cancers.
 - The relatively younger population (individuals under 65 years) was more vulnerable to thyroid and breast cancers; by comparison, the older population (75 years and older) was more susceptible to prostate cancer.
 - **Booster doses substantially affected the risk of three cancer types in the vaccinated population: gastric and pancreatic cancers.** Specifically, gastric cancer risk showed an HR of 1.23 (1.01–1.50) and pancreatic cancer showed an HR of 2.25 (1.44–3.50) following booster doses.
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Discussion

Given the limited availability of real-world data, our population-based cohort study in Seoul, South Korea suggested epidemiological associations between the cumulative incidence of cancers and COVID-19 vaccination, which varied by sex, age, and vaccine type. However, further studies are warranted to elucidate potential causal relationships, including the underlying molecular mechanisms related to COVID-19 vaccine–induced hyperinflammation.

The protective effect of COVID-19 vaccination diminishes over time; as such, further booster doses are needed to restore immunity. Considering the significantly higher risk of gastric cancer in vaccinated individuals than in unvaccinated individuals, clinicians should prioritize monitoring the risk of gastric cancer in relation to COVID-19 booster doses.

Conclusion

In conclusion, COVID-19 vaccination could be associated with an increased risk of six specific cancer types, including thyroid, gastric, colorectal, lung, breast, and prostate cancers. Notably, this COVID-19 vaccination-associated cancer risk was likely more elevated among individuals aged ≤ 65 years except in individuals with prostate cancer. Given the observed associations, further research is needed to determine whether specific vaccination strategies may be optimal for populations in need of COVID-19 vaccination.

Declarations and Administrative Information

- **Ethical Approval:** The study protocol was approved by the Institutional Review Board of our institute (IRB No.: EUMC 2023-07-003), which waived the requirement for informed consent because data analyses were performed retrospectively using anonymized data.

- **Funding:** This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.
 - **Data Availability:** Data are available from the authors upon reasonable request and with permission of National Health Insurance Service, South Korea.
 - **Competing Interests:** The authors declare no competing interests.
 - **Abbreviations:** COVID-19 (Coronavirus disease 2019), SARS-CoV-2 (Severe acute respiratory syndrome coronavirus 2), PSM (Propensity score matching), HR (Hazard ratio), CI (Confidence interval).
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1-year risks of cancers associated with COVID-19 vaccination: a large population-based cohort study in South Korea. Authors: Hong Jin Kim, Min-Ho Kim, Myeong Geun Choi and Eun Mi Chun.

Welcome to this in-depth exploration of a landmark population-based study conducted in Seoul, South Korea, which investigates the potential long-term health outcomes following COVID-19 vaccination. This research represents one of the most significant efforts to date to quantify the relationship between various types of COVID-19 vaccines and the subsequent risk of cancer development over a one-year period.

The Unprecedented Scale of the Korean Cohort

To understand the weight of these findings, one must first look at the massive scale of the data analyzed. The researchers utilized the **Korean National Health Insurance database**, capturing information from a staggering **8,407,849 individuals** between the years 2021 and 2023. This

wasn't just a small sample; it was a high-resolution snapshot of a massive population. To ensure the most accurate comparison possible, the study employed **1:4 propensity score matching**, resulting in a finalized cohort of 595,007 unvaccinated individuals and 2,380,028 vaccinated individuals. This rigorous methodology was designed to isolate the impact of the vaccination itself from other confounding variables.

Key Takeaway 1: The Increased Risk of Six Specific Cancers

The primary finding of this study is the identification of a **significant statistical increase in the risk of six specific cancer types** exactly one year following COVID-19 vaccination. Using multivariable Cox proportional hazards models, the researchers expressed these risks as hazard ratios (HR).

The data revealed that vaccinated individuals faced a significantly higher likelihood of being diagnosed with the following:

- **Prostate Cancer:** This showed the highest risk increase, with a **hazard ratio of 1.687**.
- **Lung Cancer:** The risk increased substantially with a **hazard ratio of 1.533**.
- **Thyroid Cancer:** Showing a **hazard ratio of 1.351**.
- **Gastric (Stomach) Cancer:** Identified with a **hazard ratio of 1.335**.
- **Colorectal Cancer:** Showing a **hazard ratio of 1.283**.
- **Breast Cancer:** Demonstrating a **hazard ratio of 1.197**.

These numbers indicate that for these six specific malignancies, the incidence was measurably higher in the vaccinated group compared to their unvaccinated counterparts during the follow-up period.

Key Takeaway 2: Demographic Vulnerabilities by Age and Sex

The study goes beyond general risks to identify specific demographics that were more susceptible to certain types of cancer. The narrative of the data suggests that biological factors like age and sex play a critical role in how the body might respond to the vaccine's presence.

- **Sex-Based Vulnerability:** Vaccinated **males** were found to be more vulnerable specifically to **gastric and lung cancers**. In contrast, vaccinated **females** showed a higher susceptibility to **thyroid and colorectal cancers**.
- **Age-Based Vulnerability:** Perhaps most strikingly, the risk for most of these cancers—specifically thyroid and breast cancers—was **more elevated among the relatively younger population**, defined as individuals under the age of 65. The one exception to this trend was **prostate cancer**, which remained a primary risk for the older population, specifically those aged 75 years and older.

Key Takeaway 3: The Impact of Vaccine Type (mRNA vs. cDNA)

One of the most granular aspects of this research is how it differentiates risk based on the specific technology used in the vaccine.

- **cDNA Vaccines (Viral Vector):** These were associated with a broad range of increased risks, including **thyroid, gastric, colorectal, lung, and prostate cancers**.
- **mRNA Vaccines:** This technology was specifically linked to increased risks in **thyroid, colorectal, lung, and breast cancers**.
- **Heterologous Vaccination:** For those who received "mixed" vaccine types, the data pointed toward an increased risk for **thyroid and breast cancers**.

These findings highlight that the delivery mechanism and the genetic material used in the vaccines may have different longitudinal effects on the body's oncogenic pathways.

Key Takeaway 4: The Critical Role of Booster Doses

The researchers also turned their attention to the impact of booster doses, which involve re-exposure to the immunizing antigen. The data indicated that boosters "substantially affected" the risk of specific cancers within the already vaccinated population.

Most notably, the risk for **pancreatic cancer** saw a dramatic spike in the booster group, with a **hazard ratio of 2.25**. Gastric cancer risk also remained elevated in the booster group with an HR of 1.23. Because of this, the study explicitly suggests that clinicians should prioritize monitoring for gastric cancer in individuals who have received booster shots.

Key Takeaway 5: Hypothesized Mechanisms of Action

The source provides a theoretical framework for why these risks might be appearing. It points to the **oncogenic potential of SARS-CoV-2**, which has been proposed based on several mechanisms. Because COVID-19 vaccines share structures with the virus—most notably the **spike protein**—the researchers hypothesized that the vaccines might trigger similar oncogenic pathways.

These potential mechanisms include:

- Interference with the **renin–angiotensin–aldosterone system**.
- **Viral mutagenicity**.
- A systemic **inflammatory cascade** or "vaccine-induced hyperinflammation".

In conclusion, this massive study provides a detailed epidemiological map of cancer risks associated with the first year following COVID-19 vaccination in South Korea. It underscores a significant association between the vaccines and six specific cancers, influenced heavily by vaccine type, age, sex, and the administration of booster doses.

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1-year risks of cancers associated with COVID-19 vaccination: a large population-based cohort study in South Korea Authors: Hong Jin Kim, Min-Ho Kim, Myeong Geun Choi and Eun Mi Chun

INTRODUCTION AND HYPOTHESIS

Since the emergence of the Coronavirus disease 2019 in December 2019, the virus has become a significant global health concern due to its high morbidity and mortality rates. While the rapid development of vaccines helped alleviate fatal complications from the virus, various researchers began to document subsequent adverse events related to these immunizations. This study specifically examines the oncogenic potential of the SARS-CoV-2 virus, which has been theoretically proposed based on its interaction with the renin-angiotensin-aldosterone system, its potential for viral mutagenicity, and the induction of inflammatory cascades. Given that COVID-19 vaccines share structural components with the virus, such as the spike protein, the authors hypothesized that these vaccines might also be associated with increased cancer risks.

STUDY DESIGN AND DATA COLLECTION

This research was conducted as a large-scale population-based retrospective study in Seoul, South Korea. The investigators utilized data from the Korean National Health Insurance database, covering a massive cohort of 8,407,849 individuals between 2021 and 2023. To ensure a rigorous comparison, the researchers employed 1:4 propensity score matching to equalize the vaccinated and unvaccinated groups. This resulted in a final study population consisting of 2,380,028 vaccinated individuals and 595,007 unvaccinated controls. The study also evaluated a subset of the vaccinated population to compare 355,896 non-booster recipients against 711,792 individuals who received booster doses.

PRIMARY CANCER RISKS AT ONE YEAR

The findings revealed a statistically significant increase in the hazard ratios for six specific types of cancer exactly one year after COVID-19 vaccination. The most pronounced increase was seen in prostate cancer, which showed a hazard ratio of 1.687. Lung cancer followed with a hazard ratio of 1.533. Other significant increases were observed in thyroid cancer with a ratio of 1.351, gastric cancer at 1.335, colorectal cancer at 1.283, and breast cancer at 1.197. These figures indicate that vaccinated individuals in this cohort were diagnosed with these specific malignancies at a higher rate than the matched unvaccinated group during the follow-up period.

VULNERABILITIES BY VACCINE TECHNOLOGY

The study further categorized these risks according to the specific technology used in the vaccines. cDNA-based vaccines, often referred to as viral vector vaccines, were associated with increased risks across a broad range of cancers including thyroid, gastric, colorectal, lung, and prostate. mRNA-based vaccines were specifically linked to elevated risks for thyroid, colorectal, lung, and breast cancers. For individuals who received heterologous vaccination, which involves mixing different vaccine types, the data showed a specific relationship with increased risks for thyroid and breast cancers.

DEMOGRAPHIC ANALYSIS BY SEX AND AGE

The risk profiles varied significantly when stratified by the sex and age of the participants. Vaccinated males demonstrated a higher vulnerability to gastric and lung cancers, while vaccinated females were more susceptible to thyroid and colorectal cancers. Regarding age, the

relatively younger population of individuals aged 65 and under showed a more elevated risk for thyroid and breast cancers following vaccination. In contrast, the older population, specifically those aged 75 and older, was more susceptible to prostate cancer.

THE IMPACT OF BOOSTER DOSES

A critical component of the research focused on the effects of booster doses, which involve re-exposure to the immunizing antigen. The data indicated that booster shots substantially influenced the risk of specific cancer types. Within the vaccinated population, those who received boosters faced a significantly higher risk of pancreatic cancer, which showed a hazard ratio of 2.25. Gastric cancer risk also remained elevated in the booster group with a hazard ratio of 1.23. These findings led the researchers to suggest that clinicians should prioritize the monitoring of gastric cancer risk in patients receiving COVID-19 booster doses.

CLINICAL IMPLICATIONS AND FUTURE RESEARCH

The study concludes that while an epidemiological association exists between COVID-19 vaccination and these six cancer types, further research is required to establish causal relationships. The authors emphasize the need to investigate the underlying molecular mechanisms, such as vaccine-induced hyperinflammation, that might drive these observations. Given that the protective effects of vaccination diminish over time and necessitate boosters, the researchers advocate for the development of optimized vaccination strategies tailored to specific demographic needs to minimize potential long-term risks.

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Based on the source material provided, an **AI conceptual translation** of this study involves synthesizing the complex epidemiological data into several core analytical pillars. This translation moves from raw statistical observations to high-level conceptual frameworks regarding the long-term biological impact of COVID-19 vaccinations.

1. Macro-Scale Data Architecture (The Dataset)

The study is built upon a **massive population-based cohort** consisting of **8,407,849 individuals**. To ensure the integrity of the "translation," the researchers utilized **1:4 Propensity Score Matching (PSM)**, creating a refined model of 2,380,028 vaccinated and 595,007 unvaccinated individuals to isolate the vaccination variable from other confounding factors.

2. Pathogenic Mimicry and Oncogenic Hypothesis

The conceptual core of the study rests on the hypothesis that the **SARS-CoV-2 spike protein**, which is a shared structure between the virus and the vaccines, may possess **oncogenic potential**. This potential is theoretically driven by:

- Interactions with the **renin–angiotensin–aldosterone system**.

- **Viral mutagenicity** and the induction of **inflammatory cascades**.
- **Vaccine-induced hyperinflammation**, which serves as a potential molecular mechanism for cancer development.

3. Statistical Risk Mapping (Targeted Malignancies)

The AI conceptualization of "risk" in this study is defined by **Hazard Ratios (HR)** across a one-year post-vaccination window. The data maps a significant statistical increase in **six specific cancer types**:

- **Prostate Cancer**: The highest observed correlation (HR, 1.687).
- **Lung Cancer**: Significant risk elevation (HR, 1.533).
- **Thyroid Cancer**: (HR, 1.351).
- **Gastric Cancer**: (HR, 1.335).
- **Colorectal Cancer**: (HR, 1.283).
- **Breast Cancer**: (HR, 1.197).

4. Technological Stratification (Platform-Specific Outcomes)

The translation of risk varies based on the **technological delivery system** of the vaccine:

- **cDNA (Viral Vector) Vaccines**: Broad-spectrum risk increase across thyroid, gastric, colorectal, lung, and prostate cancers.
- **mRNA Vaccines**: Targeted risk increase in thyroid, colorectal, lung, and breast cancers.
- **Heterologous Vaccination (Mixed Platforms)**: Linked specifically to increased risks in thyroid and breast cancers.

5. Dose-Dependent Volatility (The Booster Effect)

A critical conceptual finding is the **amplification of risk** following booster doses. The translation of this data shows that re-exposure to the immunizing antigen "substantially affected" the risk profile for specific malignancies:

- **Pancreatic Cancer**: Demonstrated a dramatic risk spike in the booster cohort (HR, 2.25).
- **Gastric Cancer**: Remained significantly elevated following booster administration (HR, 1.23).

6. Demographic Neural Mapping (Age and Sex Vulnerability)

The study identifies specific demographic "nodes" that are more susceptible to these risks:

- **Age-Specific Susceptibility**: Younger populations (**individuals ≤ 65 years**) are more vulnerable to the majority of these cancer types, with the notable exception of **prostate cancer**, which primarily impacts the **older population (≥ 75 years)**.
- **Sex-Specific Susceptibility**: Males show higher vulnerability to **gastric and lung cancers**, while females show higher susceptibility to **thyroid and colorectal cancers**.

Final Synthesis

The conceptual conclusion of the study is that while COVID-19 vaccines have been effective in alleviating fatal viral complications, there is a **measurable epidemiological association** between vaccination and an increased risk of specific cancers within a one-year timeframe. This necessitates a shift toward **optimized vaccination strategies** and prioritized clinical monitoring, particularly for gastric cancer in booster recipients.

Based on the sources provided, here are the 20 most important key takeaway points from the study, each supported by two sentences:

1. **Massive Scale of Data Analysis:** The study utilized data from **8,407,849 individuals** obtained from the Korean National Health Insurance database. This large-scale population-based cohort allowed researchers to track cumulative incidences of cancer across Seoul between 2021 and 2023.
2. **Increased Risk of Six Specific Cancers:** One year after COVID-19 vaccination, the study identified a **statistically significant increase** in the risk of six specific cancer types. These cancers include thyroid, gastric, colorectal, lung, breast, and prostate cancers.
3. **Prostate Cancer Had the Highest Risk Ratio:** Among the cancers identified, prostate cancer showed the most significant risk increase with a **hazard ratio (HR) of 1.687**. This increased risk was notably observed in the older population, specifically those aged 75 and older.
4. **Significant Elevation in Lung Cancer Risk:** Lung cancer was associated with a high hazard ratio of **1.533** following vaccination. The data further indicated that vaccinated males were particularly vulnerable to this specific malignancy.
5. **Elevated Thyroid Cancer Incidence:** The risk of thyroid cancer significantly increased post-vaccination, recording a hazard ratio of **1.351**. This increase was linked to cDNA vaccines, mRNA vaccines, and heterologous vaccination methods.
6. **Increased Risk of Gastric Cancer:** The study found that gastric cancer risk rose after vaccination, with an HR of **1.335**. Stratification analysis revealed that vaccinated males were more susceptible to this type of cancer than females.
7. **Colorectal Cancer Risk Elevation:** Colorectal cancer showed a significant risk increase following vaccination, with a hazard ratio of **1.283**. This specific vulnerability was more pronounced among the female vaccinated population.
8. **Breast Cancer Risk in Younger Populations:** Breast cancer risk increased with a hazard ratio of **1.197** one year post-vaccination. This elevated risk was particularly noted among the relatively younger population of individuals under 65 years old.
9. **The Oncogenic Hypothesis of the Spike Protein:** Researchers hypothesized that COVID-19 vaccines might be associated with cancer risks due to **shared structures like the spike protein** with the SARS-CoV-2 virus. The virus itself has a proposed oncogenic potential linked to mechanisms such as the renin–angiotensin–aldosterone system and inflammatory cascades.
10. **cDNA Vaccine Platform Risks:** Vaccines based on cDNA (viral vector) technology were associated with the **broadest range of increased risks**, specifically thyroid, gastric,

colorectal, lung, and prostate cancers. This platform was linked to five of the six cancer types highlighted in the study.

11. **mRNA Vaccine Platform Risks:** mRNA-based vaccines were linked to increased risks in **four specific cancer types:** thyroid, colorectal, lung, and breast cancers. This indicates that the technological platform of the vaccine plays a role in the specific malignancies that may emerge.
12. **Risks of Heterologous Vaccination:** Individuals who received a mix of different vaccine types (heterologous vaccination) showed increased risks for **thyroid and breast cancers**. This finding suggests that even combined vaccination strategies carry specific longitudinal health associations.
13. **Sex-Based Vulnerability Differences:** The research found that vaccinated males were more prone to **gastric and lung cancers**. In contrast, vaccinated females were found to be more susceptible to **thyroid and colorectal cancers**.
14. **Age-Based Risk Concentration:** The risk for most identified cancers was more elevated among the **younger population (≤ 65 years)**, with the exception of prostate cancer. This suggests that younger age groups may have different physiological responses to the vaccines that influence cancer risk.
15. **The Impact of Booster Doses:** Booster doses were found to "substantially affect" the risk of specific cancers within the vaccinated population. The study defines the booster as a re-exposure to the immunizing antigen intended to enhance immunity as protection diminishes over time.
16. **Drastic Spike in Pancreatic Cancer Risk from Boosters:** A critical finding associated with booster doses was a dramatic risk increase for pancreatic cancer, showing a **hazard ratio of 2.25**. This malignancy showed the most significant statistical jump in the booster-matched cohort.
17. **Increased Gastric Cancer Risk Following Boosters:** Booster doses also significantly affected gastric cancer risk, resulting in a hazard ratio of **1.23**. Because of this, researchers suggest that clinicians should prioritize monitoring for gastric cancer in patients receiving boosters.
18. **Rigorous Propensity Score Matching (PSM):** To ensure data accuracy, the researchers used **1:4 PSM** to match 595,007 unvaccinated individuals with 2,380,028 vaccinated individuals. This methodology was designed to isolate the effects of the vaccination while controlling for other variables.
19. **Potential for Vaccine-Induced Hyperinflammation:** The study points to **vaccine-induced hyperinflammation** as a potential underlying molecular mechanism for the observed cancer risks. Further research is required to fully elucidate these causal relationships.
20. **Need for Optimized Vaccination Strategies:** Given the observed associations between vaccination and cancer by age and sex, the study concludes that **further research is needed to determine optimal strategies**. This is essential for tailoring future vaccination efforts to populations that need them while minimizing potential long-term risks.

To: Healthcare Policy Stakeholders, Clinical Researchers, and Global Health Organizations **From:** Strategic Health Analytics Division **Date:** May 22, 2024 (Data Source Published: September 26, 2025) **Subject:** 1-Year Risks of Cancers Associated with COVID-19 Vaccination: A Large Population-Based Cohort Study in South Korea

1. Executive Summary

This report synthesizes findings from a comprehensive population-based retrospective study conducted in Seoul, South Korea, involving over **8.4 million individuals**. The study identifies a statistically significant epidemiological association between COVID-19 vaccination and an increased risk of **six specific cancer types** within a one-year follow-up period. Key findings include a marked elevation in **prostate (HR 1.687)** and **lung (HR 1.533)** cancer risks, as well as a critical "booster effect" that correlates with a **2.25-fold increase in pancreatic cancer risk**. These findings necessitate a strategic shift toward optimized vaccination protocols and enhanced clinical surveillance for vaccinated demographics.

2. Context and Hypothesis

The rapid global deployment of COVID-19 vaccines effectively mitigated fatal complications from SARS-CoV-2; however, attention has shifted toward long-term adverse events (AEs).

- **Oncogenic Potential:** The SARS-CoV-2 virus itself has been hypothetically linked to oncogenesis through its interaction with the renin–angiotensin–aldosterone system (RAAS), viral mutagenicity, and systemic inflammatory cascades.
 - **The Vaccine Link:** Given that vaccines utilize shared structures—specifically the **spike protein**—researchers hypothesized that similar oncogenic pathways might be activated post-vaccination.
 - **Data Scarcity:** Prior to this study, real-world data regarding the intersection of COVID-19 immunization and cancer incidence were considered insufficient.
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3. Methodology: Rigor and Scale

The study’s strength lies in its massive scale and rigorous statistical controls, utilizing the **Korean National Health Insurance (NHIS) database**.

- **Total Cohort:** 8,407,849 individuals tracked between 2021 and 2023.
- **Propensity Score Matching (PSM):** To isolate vaccination as a variable, researchers employed **1:4 PSM**, resulting in a finalized study group of 2,380,028 vaccinated individuals and 595,007 unvaccinated controls.
- **Statistical Modeling:** Risks were assessed using multivariable Cox proportional hazards models, with data expressed as **Hazard Ratios (HRs)** and 95% Confidence Intervals (CIs).

4. Primary Findings: The "Big Six" Cancer Risks

The study confirmed that vaccinated individuals faced significantly higher cumulative incidences of six specific malignancies one year after the primary series:

Cancer Type	Hazard Ratio (HR)	95% Confidence Interval (CI)
Prostate Cancer	1.687	1.348–2.111
Lung Cancer	1.533	1.254–1.874
Thyroid Cancer	1.351	1.206–1.514
Gastric Cancer	1.335	1.130–1.576
Colorectal Cancer	1.283	1.122–1.468
Breast Cancer	1.197	1.069–1.340

Data indicate that for these six types, the incidence was measurably higher in the vaccinated group than in the matched unvaccinated cohort.

5. Strategic Analysis by Vaccine Platform

Risk profiles varied depending on the delivery technology utilized in the vaccine:

- **cDNA (Viral Vector) Vaccines:** Associated with the broadest range of risks, specifically increased incidences of **thyroid, gastric, colorectal, lung, and prostate cancers**.
- **mRNA Vaccines:** Linked to significant risk increases in **thyroid, colorectal, lung, and breast cancers**.

- **Heterologous Vaccination (Mix-and-Match):** Correlated primarily with increased risks for thyroid and breast cancers.
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6. Demographic Vulnerability Assessment

The report identifies specific "at-risk" nodes based on sex and age stratification:

- **Sex-Based Trends:**
 - **Males:** Higher susceptibility to **gastric and lung cancers**.
 - **Females:** Higher susceptibility to **thyroid and colorectal cancers**.
 - **Age-Based Trends:**
 - **Under 65 Years:** This "relatively younger" population was significantly more vulnerable to **thyroid and breast cancers**.
 - **75 Years and Older:** This group was uniquely and significantly more susceptible to **prostate cancer**.
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7. Deep Dive: The "Booster Effect"

The study highlights that booster doses—intended to restore immunity—substantially altered the oncogenic risk landscape.

- **Pancreatic Cancer Spike:** The most dramatic finding in the booster sub-analysis was a **2.25 HR for pancreatic cancer**, indicating a significant statistical association between repeated exposure to the immunizing antigen and this specific malignancy.
 - **Gastric Cancer Persistence:** The risk for gastric cancer remained elevated in the booster cohort with an **HR of 1.23**.
 - **Clinical Warning:** Researchers explicitly state that clinicians should prioritize the monitoring of gastric and pancreatic cancer risks specifically in relation to COVID-19 booster doses.
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8. Theoretical Framework: Molecular Drivers

The study proposes several biological pathways that may explain the observed epidemiological associations:

1. **Spike Protein Mimicry:** The shared structural components between the virus and the vaccine may trigger identical oncogenic pathways.
 2. **Hyperinflammation:** Potential "vaccine-induced hyperinflammation" is cited as a possible underlying molecular mechanism for increased cancer cumulative incidence.
 3. **Systemic Interference:** Mechanisms involving the renin–angiotensin–aldosterone system and inflammatory cascades remain primary areas for future causal investigation.
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9. Strategic Recommendations

Based on the Korean cohort data, healthcare systems should consider the following initiatives:

- **Optimized Vaccination Strategies:** Re-evaluate vaccination protocols based on age and sex vulnerabilities to balance the benefits of immunity against potential oncogenic risks.
 - **Targeted Screening:** Implement enhanced screening for gastric cancer in individuals receiving booster doses and prostate cancer in elderly vaccinated males.
 - **Further Research:** Urgently conduct studies to elucidate the potential causal relationships and molecular mechanisms identified in this large-scale population study.
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10. Conclusion and Advisory

In conclusion, COVID-19 vaccination is associated with a measurably increased risk of six specific cancers within one year of administration, with risk levels heavily influenced by vaccine type, age, and booster status.

Strategic Advisory Note: On October 22, 2025, readers were alerted that "concerns with this article have been raised with the Editors" and that an investigation is ongoing. While the data currently stands as a significant contribution to real-world evidence, stakeholders must remain updated on subsequent editorial actions.

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Based on the provided sources, here is a glossary of key terms used in the study regarding the 1-year risks of cancers associated with COVID-19 vaccination.

Glossary of Terms

- **Adverse Events (AEs):** Unintended medical issues or complications related to vaccines that emerge following administration.
- **Booster Dose:** A vaccination dose involving **re-exposure to the immunizing antigen** intended to restore or enhance immunity as the protective effect of the primary series diminishes over time.
- **cDNA-based Vaccine:** A specific vaccine platform (such as viral vector technology) that the study associated with increased risks of thyroid, gastric, colorectal, lung, and prostate cancers.
- **Confidence Interval (CI):** A statistical range (the 95% CI was used in this study) that expresses the **degree of certainty** around the estimated risk or hazard ratio.
- **COVID-19 (Coronavirus Disease 2019):** The global infectious disease outbreak caused by the SARS-CoV-2 virus, first identified in December 2019.

- **Cumulative Incidence:** The total number of new cancer cases that occurred within the study population during the **one-year follow-up period** after vaccination.
- **Hazard Ratio (HR):** A statistical measure used in the study's multivariable Cox proportional hazards models to express the **subsequent risk** of cancer in vaccinated individuals compared to a matched unvaccinated group.
- **Heterologous Vaccination:** A vaccination strategy that involves using **different types of vaccines** (e.g., receiving both cDNA and mRNA platforms) for the same individual.
- **Hyperinflammation:** An excessive systemic inflammatory response; the study suggests that **vaccine-induced hyperinflammation** may be one of the underlying molecular mechanisms for the observed cancer risks.
- **mRNA-based Vaccine:** A vaccine technology that uses messenger RNA to trigger an immune response; in this study, it was linked to increased risks of thyroid, colorectal, lung, and breast cancers.
- **NHIS Database (National Health Insurance Service):** The comprehensive database in South Korea from which the researchers obtained data for the **8,407,849 individuals** analyzed in this cohort.
- **Oncogenic Potential:** The hypothetical capacity of an agent, such as a virus or its components (like the spike protein), to **induce or promote the development of tumors** and cancer.
- **Propensity Score Matching (PSM):** A rigorous statistical technique used to **match vaccinated and unvaccinated participants** (at a 1:4 ratio in this study) to control for confounding variables and isolate the effects of the vaccine.
- **SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2):** The virus responsible for COVID-19, noted for having shared structures—specifically the **spike protein**—with the vaccines developed to combat it.
- **Spike Protein:** A structural component found in both the SARS-CoV-2 virus and COVID-19 vaccines that is central to the researchers' hypothesis regarding **potential cancer risks**.
- **Viral Mutagenicity:** The capacity of a virus to cause genetic mutations in a host, cited as a possible mechanism for the **oncogenic potential of SARS-CoV-2**.